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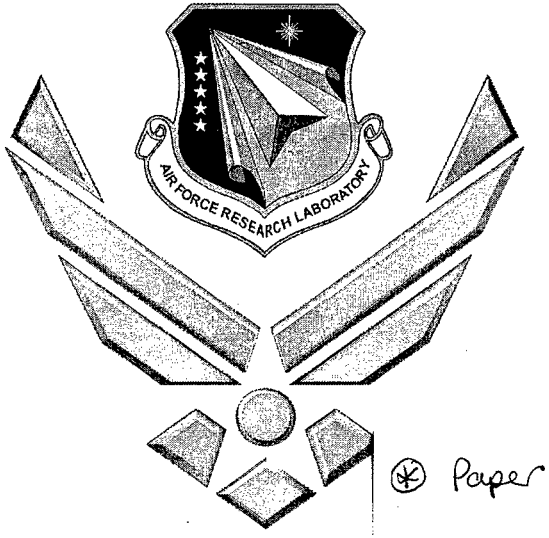
2 items enclosed = 212 + 211

"Effects on Processing by Drop-in Modifiers in Nano-Composite Polymers "



Patrick Ruth,
Senior Technician, AFRL/PRSM
Air Force Research Lab, Edwards
Brent Viers, Rusty Blanski, and Andre Lee

⊛ Paper Rec'd After 30-day Deadline = { 22 days until Deadline }

FILE

MEMORANDUM FOR PRS (In-House Contractor Publication)

FROM: PROI (STINFO) 03 Sept 2002

SUBJECT: Authorization for Release of Technical Information, Control Number: **AFRL-PR-ED-VG-2002-212**
Patrick Ruth (ERC) et al., "Effects on Processing by Drop-in Modifiers in Nano-Composite Polymers" (viewgraphs)

POSS Nanotechnology Conference **(Statement A)**
(Huntington Beach, CA, 25-27 September 2002) **(Deadline: 25 Sept 02)**

POSS As a Drop-in Modifier- Introduction

What is POSS? (Simplified)

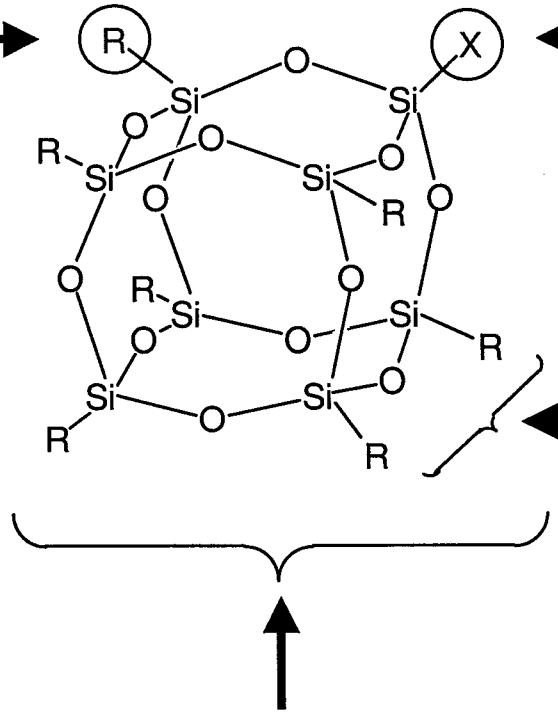
1. Structure
2. Functional Groups and Dropping-in
3. Proposed and Actual uses

Making Samples

1. Material Selection and Preparation
2. Blending
3. Sample Production

Anatomy of a Polyhedral Oligomeric Silsesquioxane (POSS™) Molecule

Nonreactive organic (R) groups for solubilization and compatibilization.



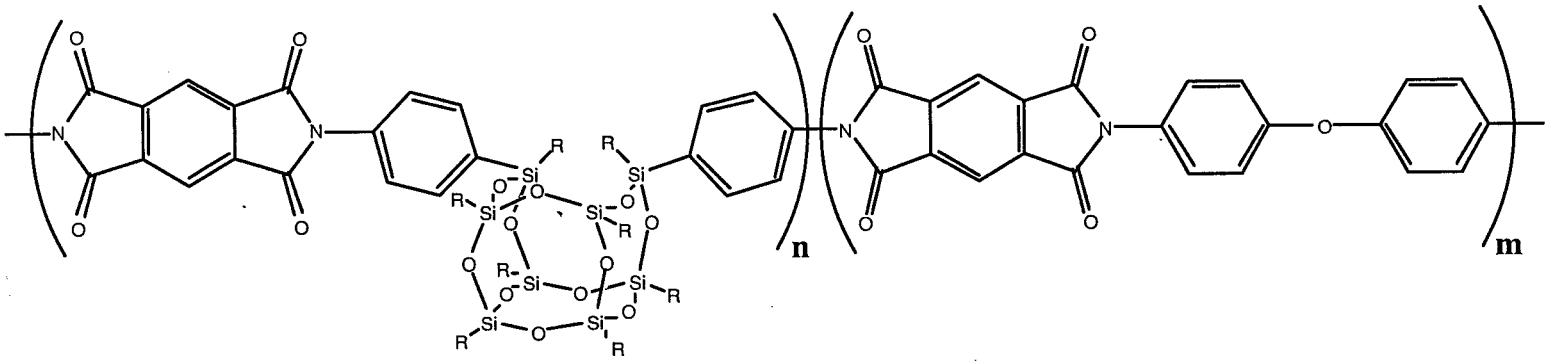
May possess one or more functional groups suitable for polymerization or grafting.

Nanoscopic in size with an Si-Si distance of 0.5 nm and a R-R distance of 1.5 nm.

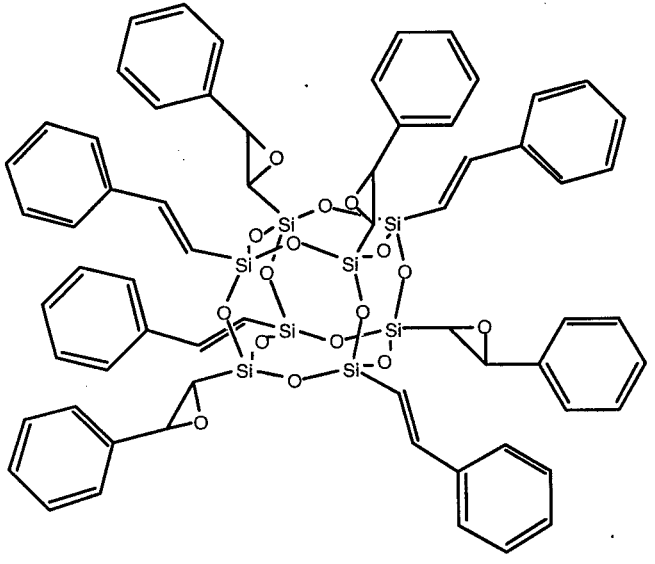
Thermally and chemically robust hybrid (organic-inorganic) framework.

Precise three-dimensional structure for molecular level reinforcement of polymer segments and coils.

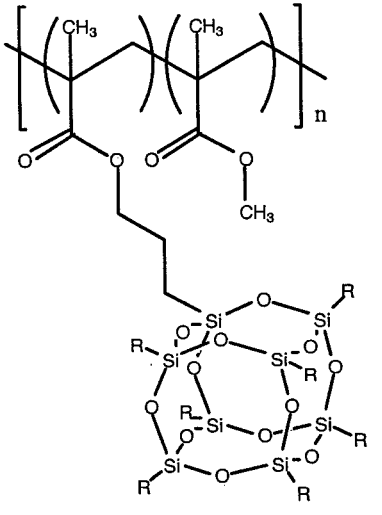
POSS Chemically Incorporated into Plastics



POSS-Kapton

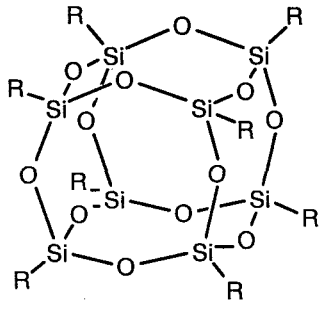


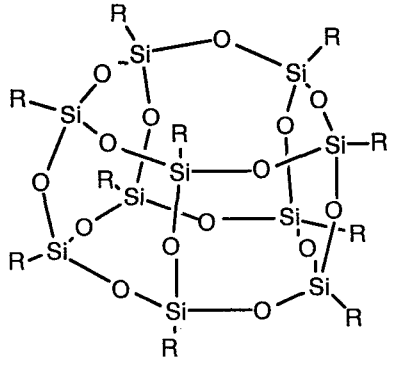
POSS-EPOXY

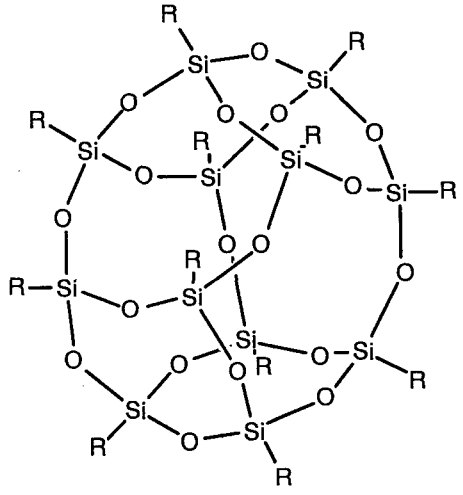


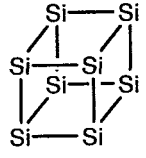
POSS-PMMA

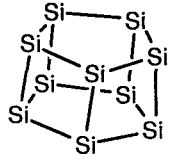
POSS Blended into Plastics

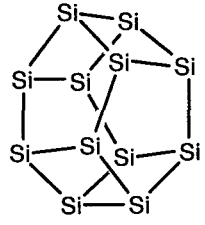






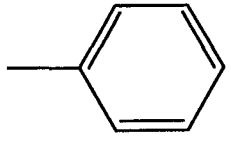


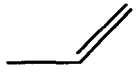


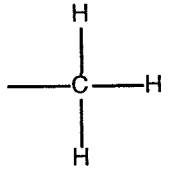


T_8 T_{10} T_{12}

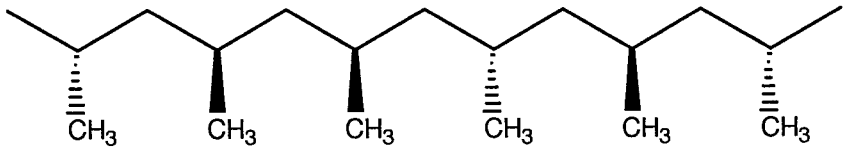
R =



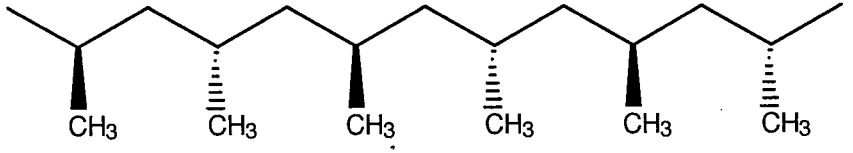




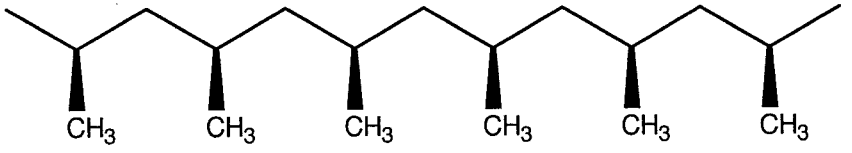
Materials Selection: Polypropylene and POSS



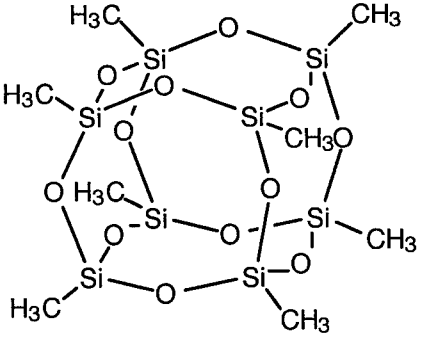
atactic polypropylene



syndiotactic polypropylene

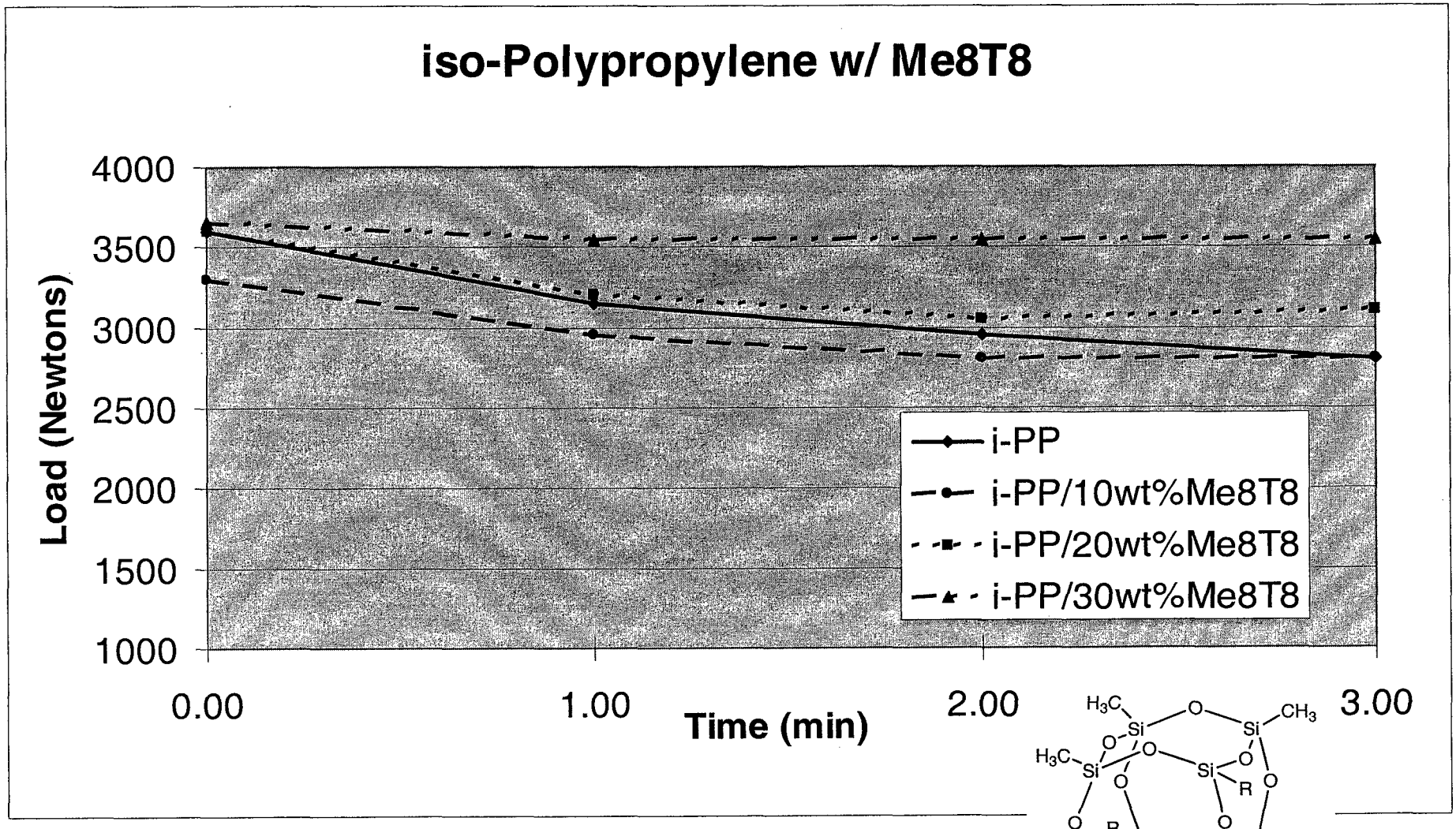


isotactic Polypropylene



$Methyl_8T_8$

i-PP/Me_8T_8 Processing Studies

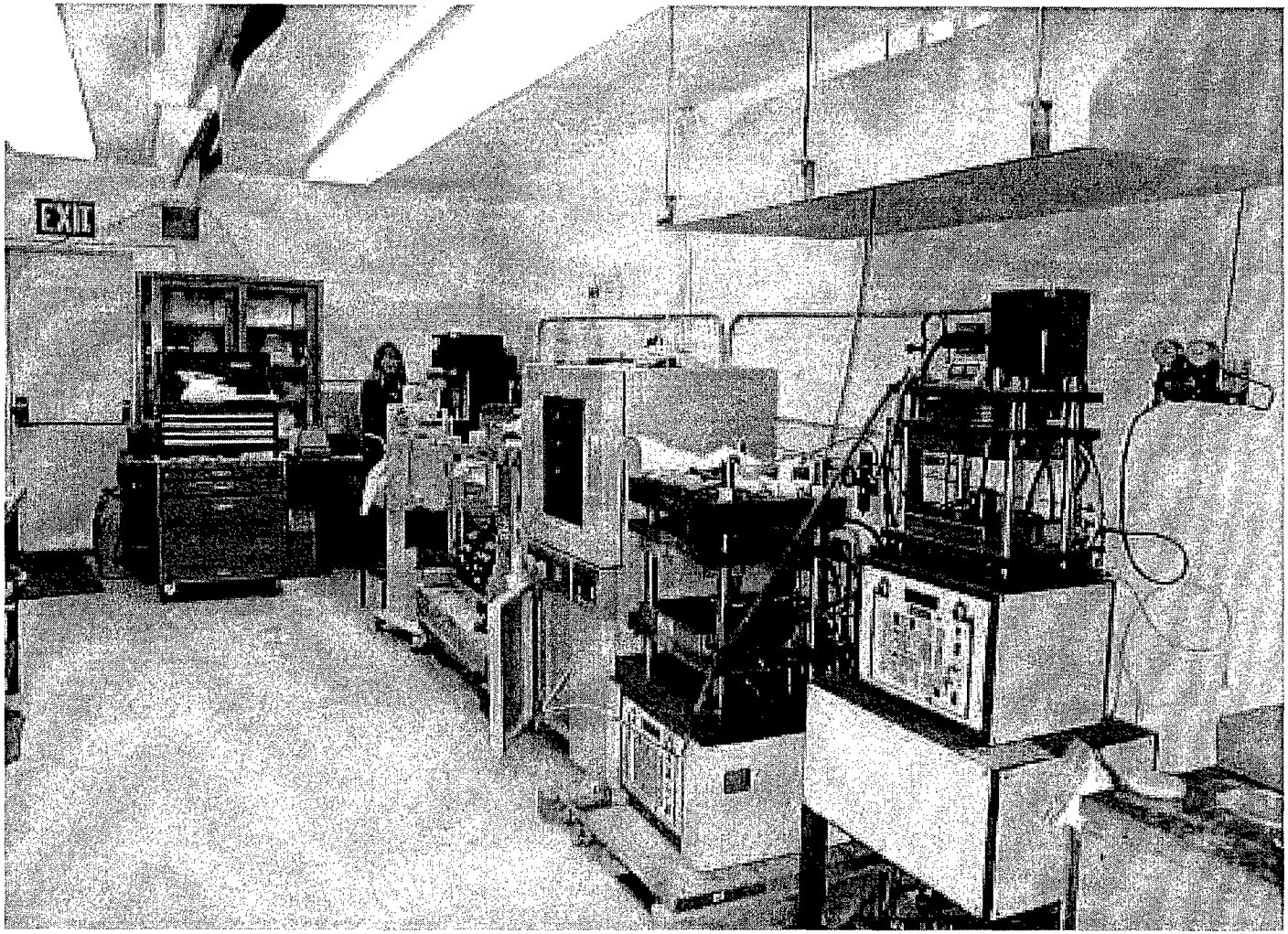


Prof. Andre Lee - Michigan State University

	Dow data	Neat *i*-PP (processed)	*i*-PP blended 2 wt% $Methyl_8T_8$	*i*-PP blended 5 wt% $Methyl_8T_8$	*i*-PP blended 10 wt% $Methyl_8T_8$
Tensile Strength @ Yield; ASTM D638	5000 psi (34.5 MPa)	4800 psi (33.0 MPa)	5000 psi (34.5 MPa)	5100 psi (35.1 MPa)	5200 psi (35.8 MPa)
Flexural Modulus (0.05 in/min, 1% secant); ASTM D790A	240,000 psi (1.655 GPa)	235,000 psi (1.620 GPa)	251,000 psi (1.730 GPa)	255,000 psi (1.757 GPa)	262,000 psi (1.80 GPa)
HDT @ 66 psi, as injected; ASTM D648	210 °F (99 °C)	210 °F (99 °C)	221 °F (105 °C)	239 °F (115 °C)	255 °F (124 °C)
Impact Izod @25C ASTM D256A	0.5 ft-lb/in	0.55 ft-lb/in	0.55 ft-lb/in	0.62 ft-lb/in	0.75 ft-lb/in

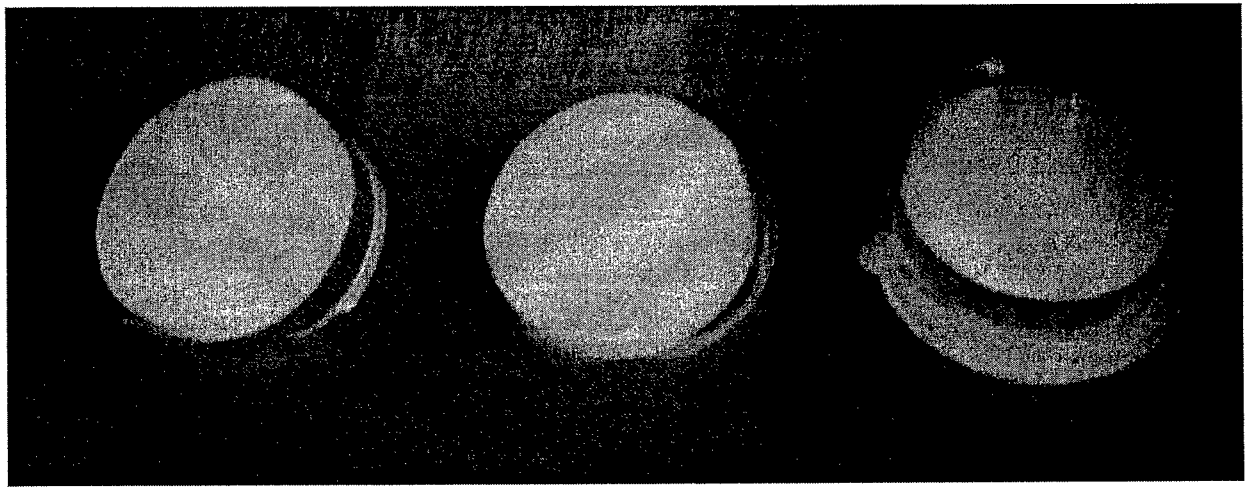
- **The above data (other than Dow's data) is an average of at least 10 samples for each test with acceptable S.D. of 5% or better.**

Polymer Processing Lab



Polymer Processing Parameters

- Time (10 Min)
- Pressure (Varied)
- Temperature (216C)

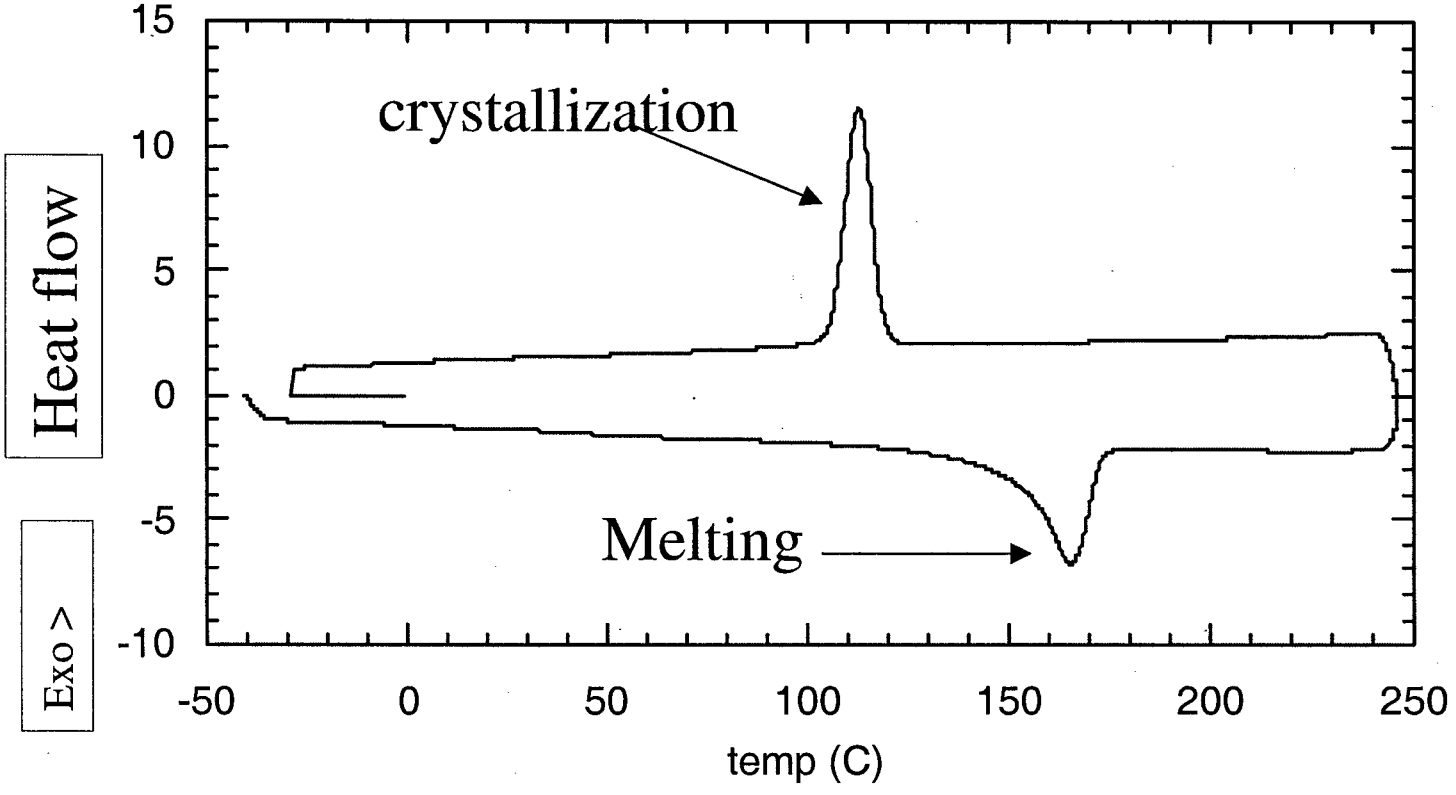


500 PSI 1000 PSI 2000PSI

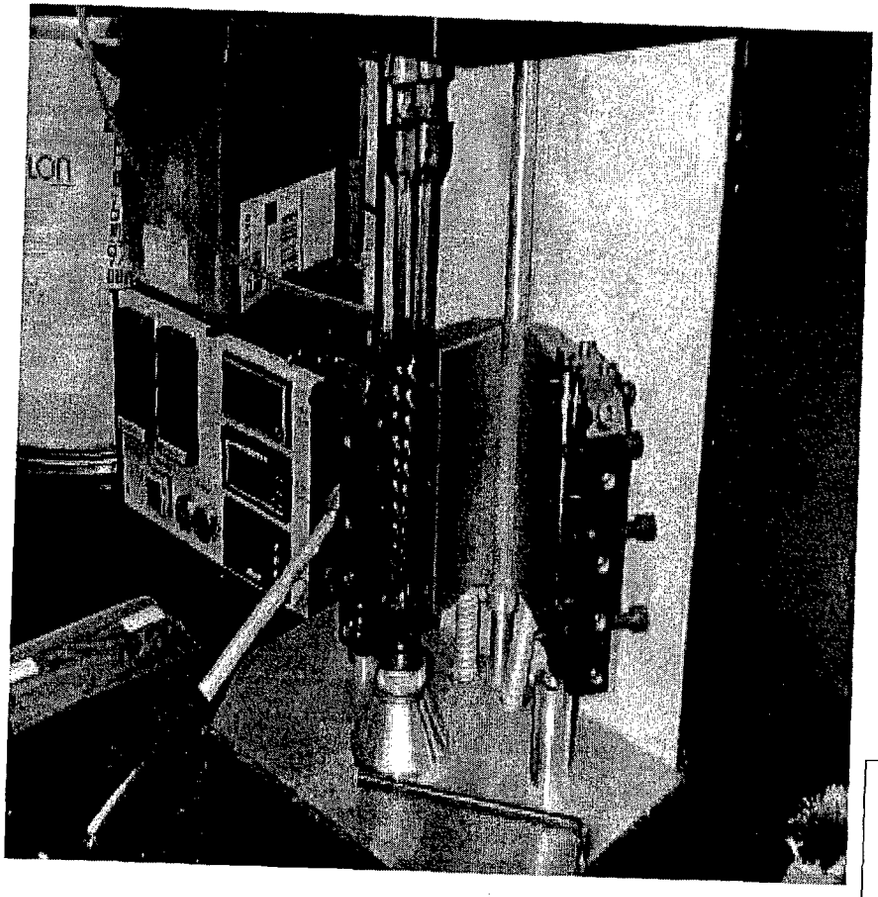
Procedure

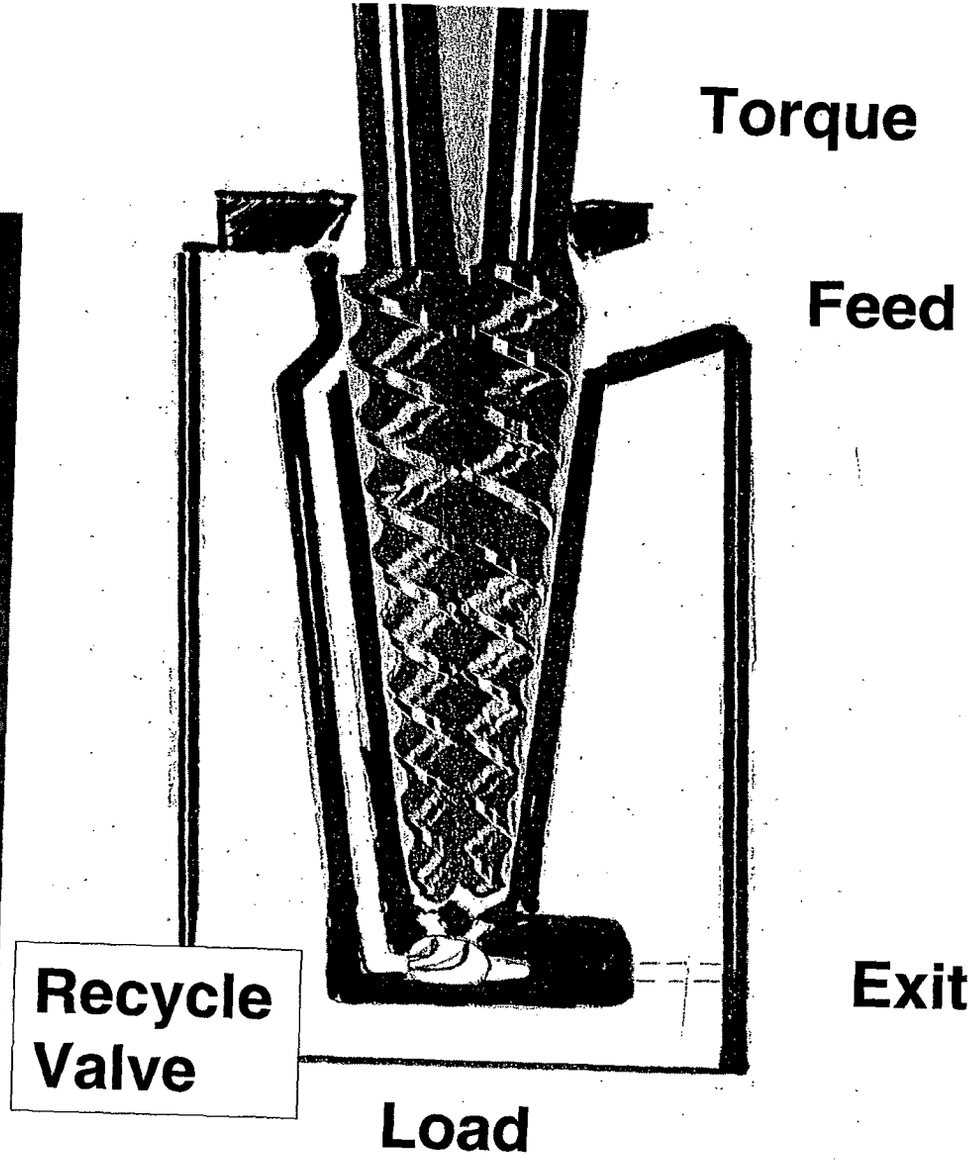
- DSC (Establish processing and drying temperatures)
- Drying (Vacuum Oven)
- DACA (Mixing)
- Press (Forming samples)
- Tests to compare properties

Polypropylene DSC



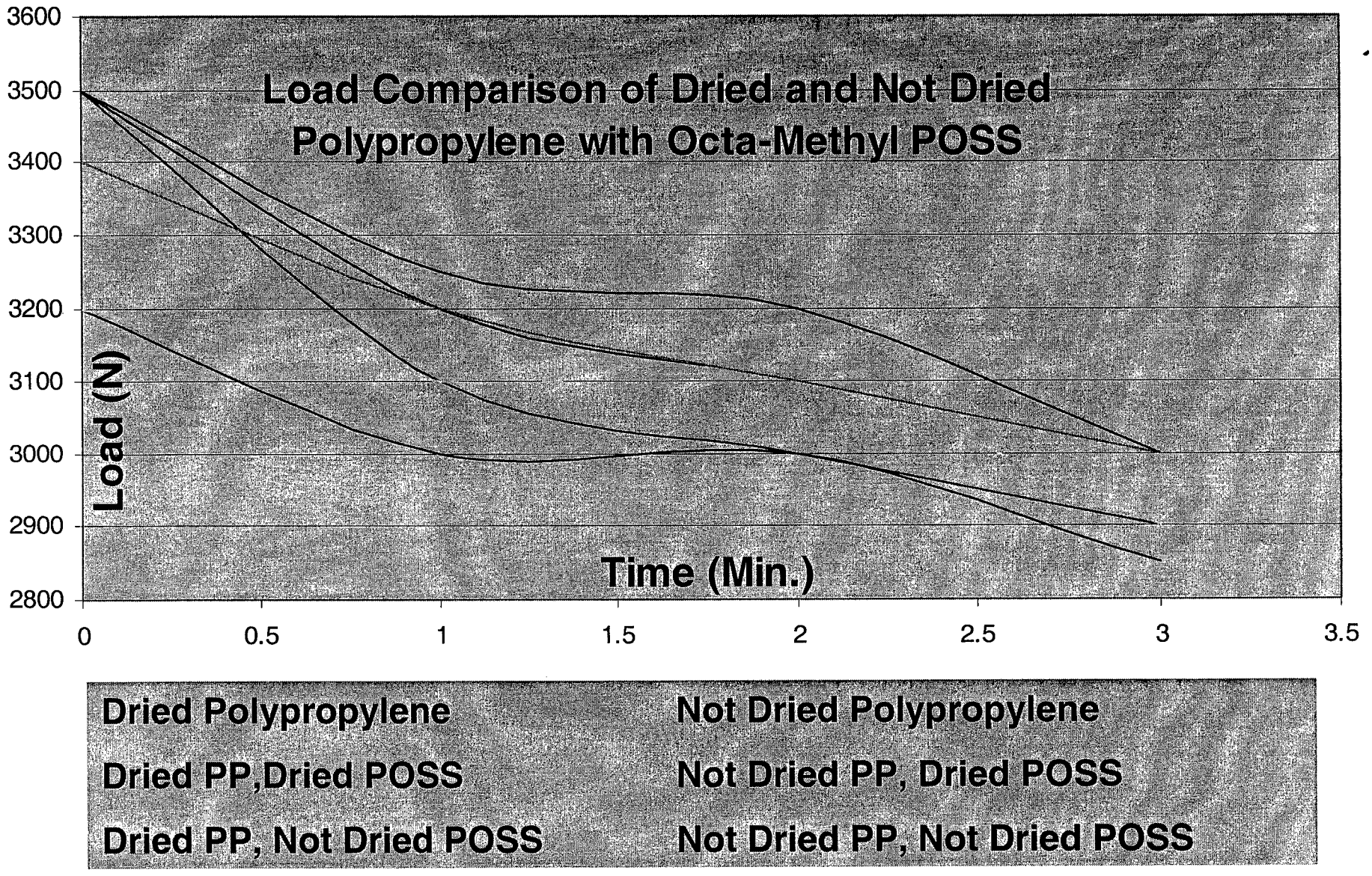
DACA Twin-screw Extruder

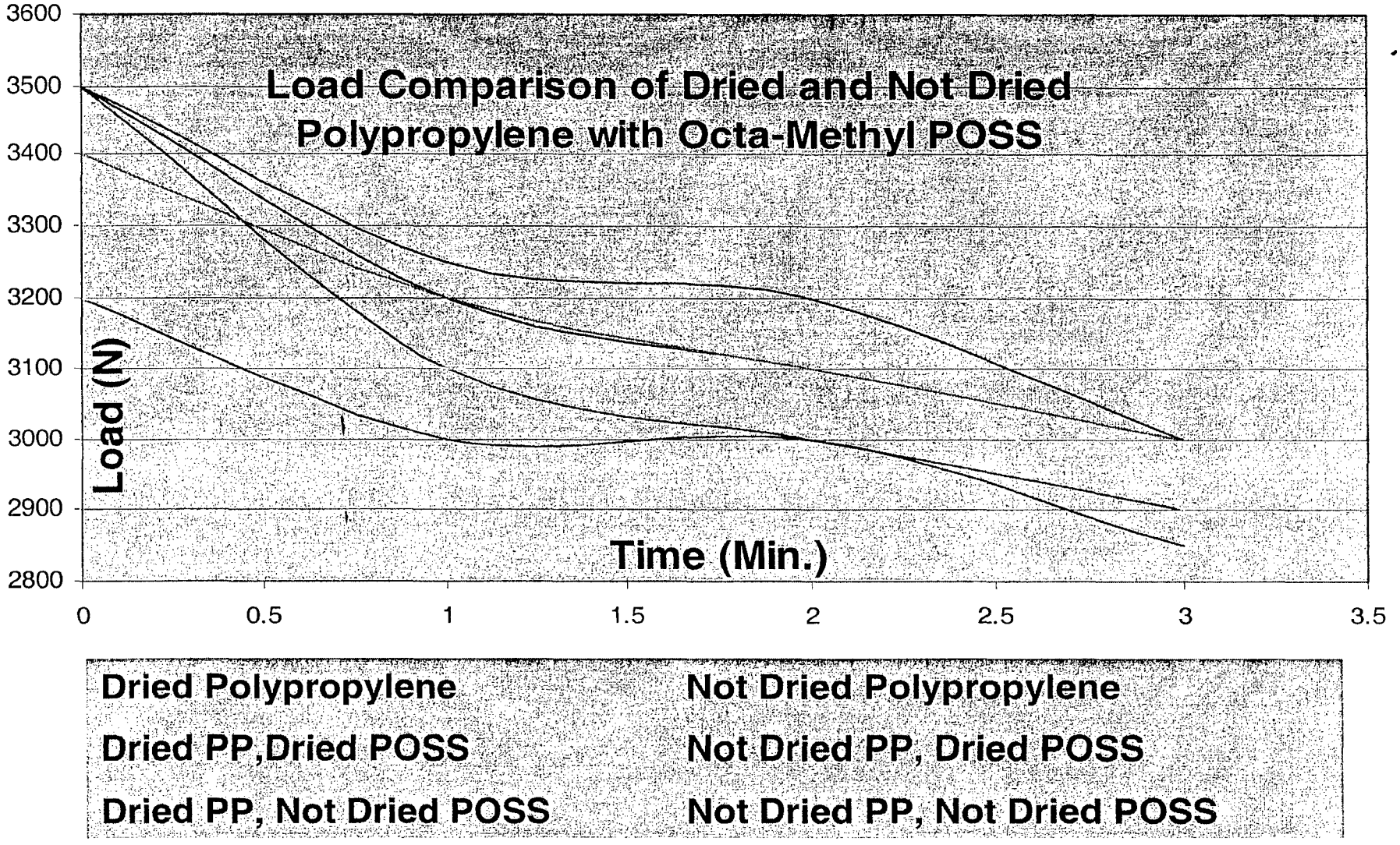


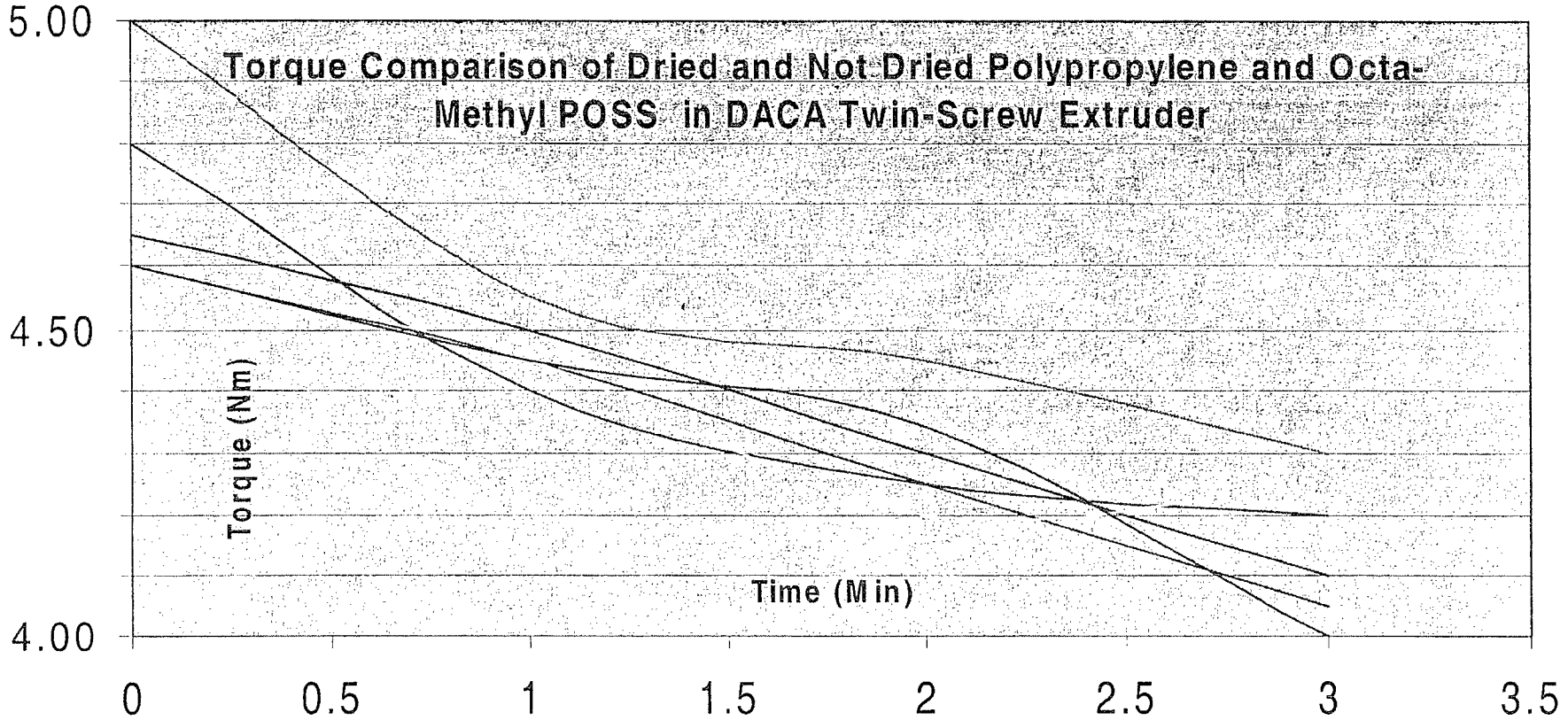


DACA Twin Screw Processing Parameters for Me8T8/iPP nanocomposite blends.

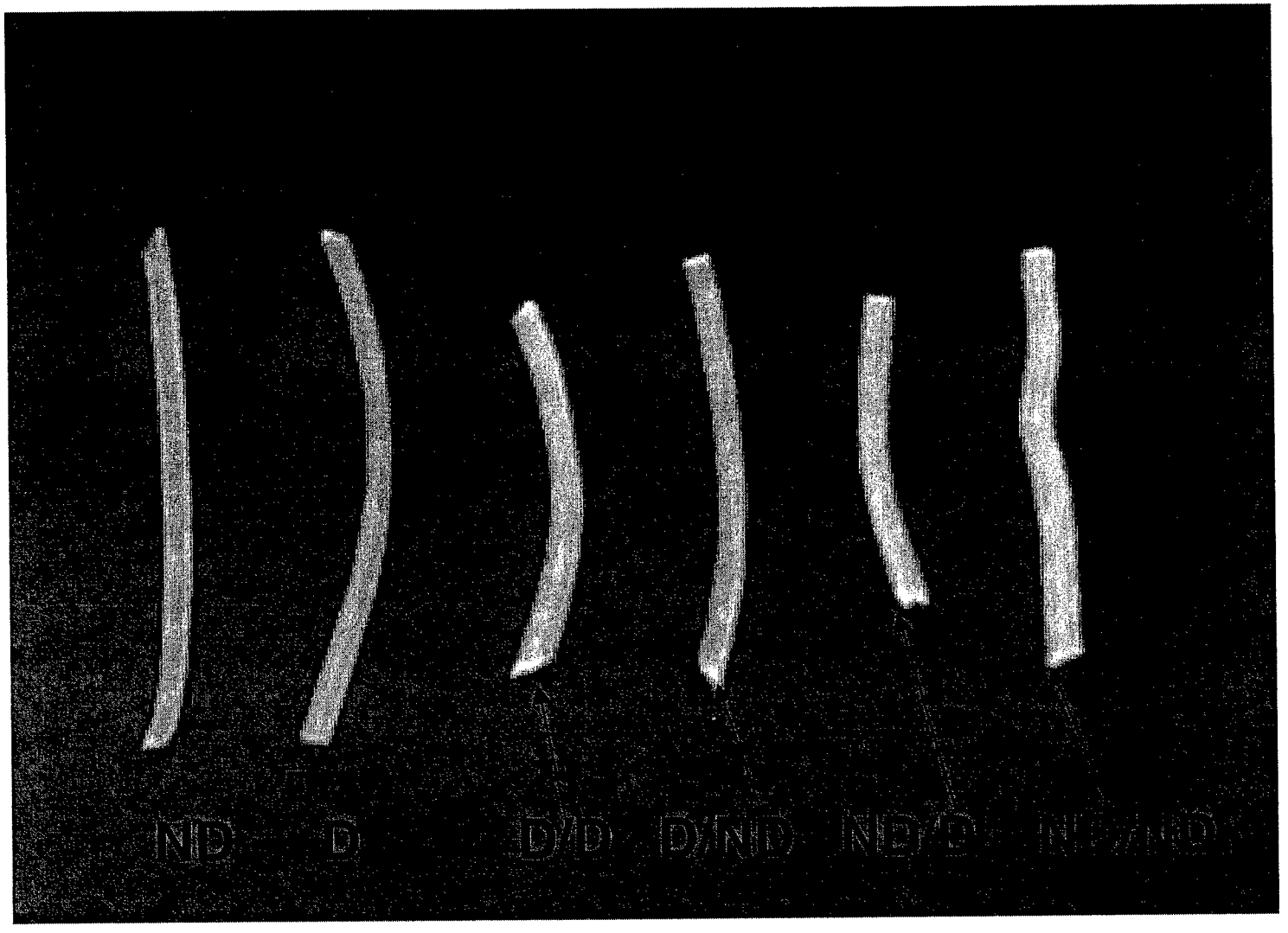
Mix #	Material Percentage				Load (N)				Torque (Nm)			
	PP		Me_8T_8		Mix Duration (min)				Mix Duration (Min)			
	Dried	Not Dried	Dried	Not Dried	0	1	2	3	0	1	2	3
1		100			3500	3200	3100	3000	4.65	4.50	4.30	4.10
2	100				3500	3100	3000	2900	4.60	4.45	4.25	4.05
3	90		10		3200	3000	3000	2850	4.80	4.40	4.25	4.20
4	90			10	3200	3100	3100	2900	4.60	4.45	4.20	4.25
5		90	10		3500	3250	3200	3000	5.00	4.55	4.45	4.30
6		90		10	3400	3200	3100	3000	4.60	4.45	4.34	4.00


Load Comparison of Dried and Not Dried Polypropylene with Octa-Methyl POSS
Load (N)
Time (Min.)
3600
3500
3400
3300
3200
3100
3000
2900
2800
0
0.5
1
1.5
2
2.5
3
3.5
Dried Polypropylene
Not Dried Polypropylene
Dried PP,Dried POSS
Not Dried PP, Dried POSS
Dried PP, Not Dried POSS
Not Dried PP, Not Dried POSS

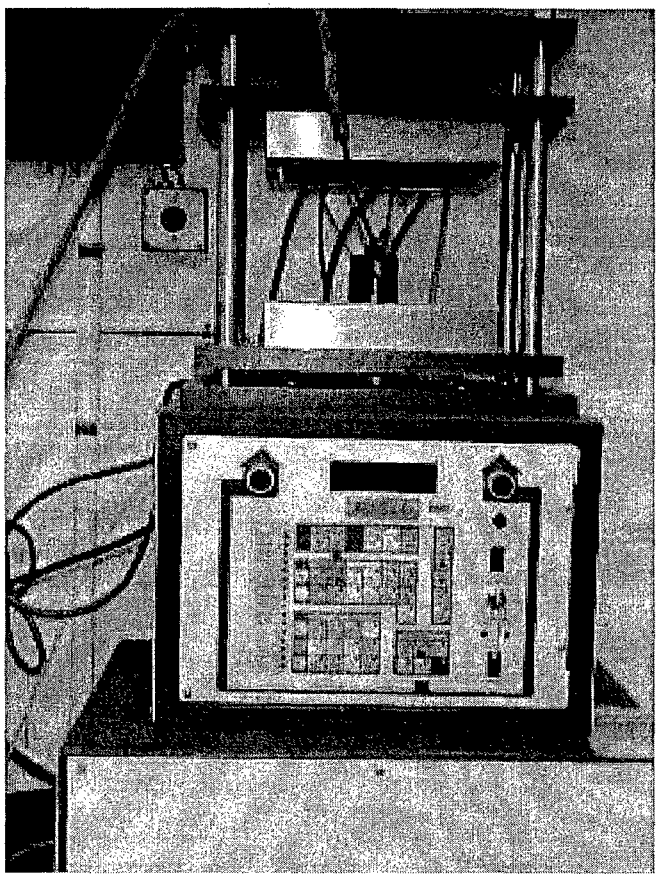

Load Comparison of Dried and Not Dried Polypropylene with Octa-Methyl POSS
Load (N)
Time (Min.)
3600
3500
3400
3300
3200
3100
3000
2900
2800
0
0.5
1
1.5
2
2.5
3
3.5
Dried Polypropylene
Not Dried Polypropylene
Dried PP,Dried POSS
Not Dried PP, Dried POSS
Dried PP, Not Dried POSS
Not Dried PP, Not Dried POSS


Torque Comparison of Dried and Not Dried Polypropylene and Octa-Methyl POSS in DACA Twin-Screw Extruder
Torque (Nm)
Time (Min)
5.00
4.50
4.00
0
0.5
1
1.5
2
2.5
3
3.5
Dried Polypropylene
Not Dried Polypropylene
Dried PP,Dried POSS
Not Dried PP, Dried POSS
Dried PP, Not Dried POSS
Not Dried PP, Not Dried POSS

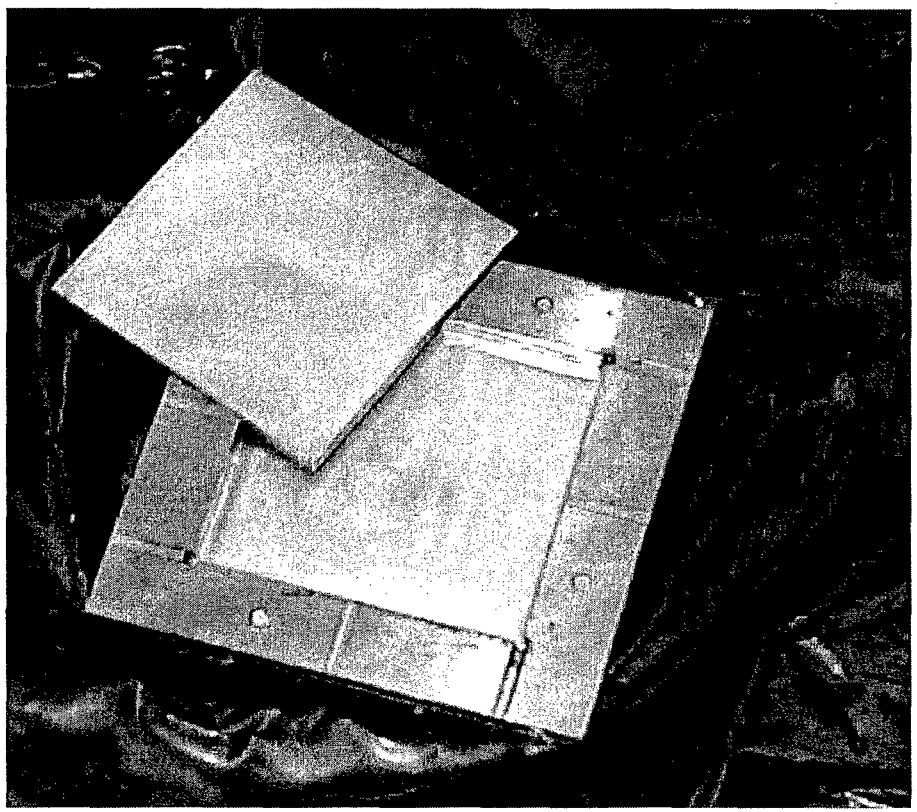
Polypropylene/Me_8t_8 Extrudates



Hot Press

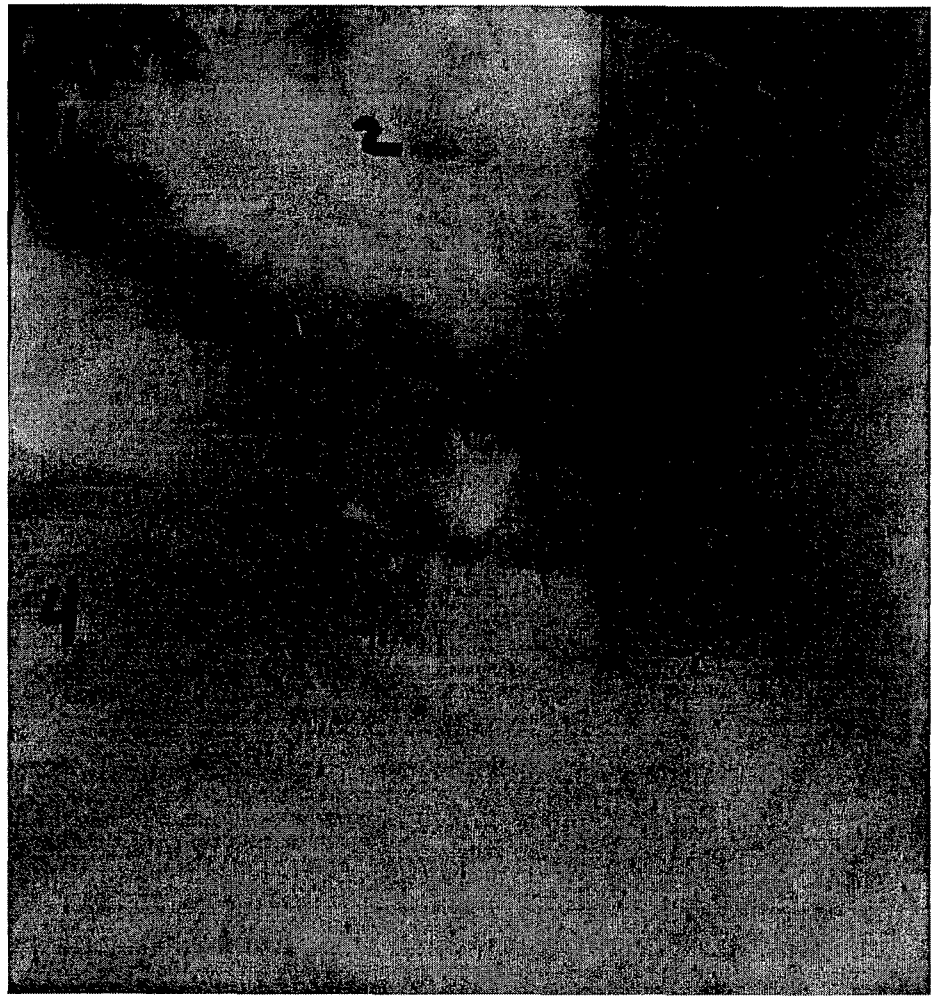


4 X4 Inch Mold



Pressed Film of DACA Extruded POSS/PP Blend Variants

1 Not Dried PP
2 Dried PP
3 Dried PP, Dried POSS
4 Dried PP, Not Dried POSS
5 Not Dried PP, Dried POSS
6 Not Dried PP, Not Dried POSS



SUMMARY

Drying plays a role in making Me_8T_8 compatible with isotactic polypropylene

Load/torque to mix the polymer with the POSS is increased if either of the components is not dried.

Visually, the most compatible of the mixes is where both POSS and PP components were dried. The extruded rod and pressed thin film are nearly as clear as pure polypropylene in the melt.

ACKNOWLEDGEMENTS

AFRL/PRSM: Dr. Brent Viers, Dr. Rusty Blanski, and Dr. Andre Lee
Air Force Research Lab Polymer Working Group

Hybrid Plastics: Dr. Joe Lichtenhan, Dr. Joe Schwab, and
Mr. Michael J Carr

This talk is as much about me learning my work as it is making samples. A great deal of thanks goes to the people who do similar work and have shown me tricks to make the technician look clever.